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Release of Young Spruce and Pine from Alder Competition

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Newfoundland Forest Research Centre

N-X-211

89-00152/

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by J. Richardson

INFORMATION REPORT N-X-211
1982

NEWFOUNDLAND FOREST RESEARCH CENTRE
CANADIAN FORESTRY SERVICE
ENVIRONMENT CANADA

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ISSN No. 0704-7657
CAT. No. Fo46-15/211E
ISBN No. 0-662-12310-7

Copies of this report are available from:

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ABSTRACT

The herbicides Tordon and 2,4-D (applied during and after shoot growth) and brushcutting were tested for releasing a young stand of black spruce and jack pine from overtopping alders and other hardwoods in central Newfoundland. Four years after application, all treatments, except 2,4-D applied after shoot growth, had resulted in increased softwood leader growth. Application of 2,4-D during hardwood shoot growth was the most successful treatment. Tordon and brushcutting caused more mortality and damage to spruce and pine than 2,4-D. Enchanced softwood growth was only evident where the hardwoods were more than twice as tall as the softwoods before treatment.

RÉSUMÉ

Quatre ans après l'expérimentation des herbicides Tordon et 2,4-D (pendant et après la croissance des pousses) et de la coupe des broussailles pour dégager un jeune peuplement d'épinette noire et de pin gris du centre de Terre-Neuve et soustraire ces résineux à la dominance des aulnes et d'autres feuillus, tous ces traitements, sauf au 2,4-D après la croissance des pousses, se sont traduits par la croissance accrue de la pousse principale. Le traitement le plus efficace a été celui au 2,4-D pendant la pousse. Le Tordon et la coupe des broussailles ont causé plus de mortalité et de dommages aux résineux que le 2,4-D. La croissance améliorée des résineux n'était observable que là où les feuillus les dépassaient de plus du double, avant le traitement.

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INTRODUCTION

Competition from undesirable vegetation is a common problem for regenerating young softwood stands, especially on more productive sites. Growth rates of softwood regeneration may be severely restricted by the competition, essentially removing the sites from commercial softwood production in some cases. Hardwood release techniques have been commonly practised in forest management in some sections of the boreal forest in Canada. Good results have been achieved with both mechanical (Hatcher, 1967) and chemical (Sutton, 1970) techniques.

On moist nutrient-rich sites in central Newfoundland, extensive areas which formerly supported productive stands of black spruce (Picea mariana (Mill.) B.S.P.) and balsam fir (Abies balsamea (L.) Mill.) have been taken over by dense vigorous stands of speckled alder (Alnus rugosa (Du Roi) Spreng. var. americana (Regel) Fern.) following wildfire. White birch (Betula papyrifera Marsh.) and trembling aspen (Populus tremuloides Michx.) may be present with the alders. Softwoods, such as black spruce can be established by direct seeding on these sites when freshly burned, but subsequent overtopping by hardwoods occurs (Richardson 1973). An experiment was established in 1975 to compare several chemical and one mechanical release technique in a young stand of black spruce

and jack pine (Pinus banksiana Lamb.) established by aerial seeding and subsequently overtopped by alders and other hardwoods. The results of the experiment up to four years after treatment are reported here.

MATERIALS AND METHODS

The Experiment. A total area of 4 ha is involved in the experiment with individual treatment plots being 0.2 ha in area (50 m x 40 m). The following treatments were compared in a randomized complete block design with four replications:

a. July application of 2,4-D ('early' application)

b. August application of 2,4-D ('late' application)

c. Tordon 10K pellet application

d. Brushcutting

e. Control

The 2,4-D, a selective herbicide, was applied at the rate of 1.1 kg acid equivalent per ha of the amine formulation in about 400 l of water per ha using a portable back-pack type mistblower. The 'early' application was made on July 8-9, 1975 during the period of active hardwood shoot growth, and the 'late' application on August 6-7, 1975 after shoot growth was almost complete. Tordon 10K pellets containing 10 percent acid equivalent of the potassium salt of 4-amino-3,5,6-trichloropicolinic acid (picloram) were applied on July 3-4, 1975 at the rate of 40 kg per ha; the pellets of Tordon, a non-selective herbicide, were spread by hand, concentrating them on the alder clumps. Brushcutting was carried out between late August and October using a portable motorized brushcutter

and axes to cut all hardwood stems close to ground level. The density and growth of the softwood regeneration and hardwood canopy were determined in spring 1975 prior to applying the treatments (Richardson, 1979a).

Post-treatment examinations were conducted in May 1976 (for treatment damage to softwoods), August 1976 (for effects of treatments on hardwoods), and September 1977 and 1979 (complete remeasurements). On each occasion, two randomly-located groups of 25 permanent 4 m^2 (2 m x 2 m) quadrats were examined within each plot. The following information was recorded on each quadrat: number and condition of spruce and pine seedlings; total height and leader length of the tallest spruce and pine; average height and cover of hardwoods; and number and condition of hardwood stems. 'Condition' was categorized as 'live, undamaged', 'live, damaged', or 'dead', and notes were made of the nature of the damage. Hardwood cover was estimated by eye in tenths of quadrat area with reference to ground level when the hardwoods were in full leaf.

Data were compiled, tabulated and subjected to analysis of variance where appropriate in accordance with standard statistical procedures. Differences between means were tested for significance using Tukey's w-procedure (Steel and Torrie, 1960).

Site and Vegetation. The experiment is located in the North Pond forest experiment area (48°40'N, 54°30'W) near Gander in east-central Newfoundland within Section B.28a of the Boreal Forest Region (Rowe, 1972). It is situated on a gentle north-facing slope with well-drained stony sandy-loam soils derived from underlying glacial till. The organic layer is thin (generally less than 3 cm).

The site supported a mature stand of black spruce and balsam fir prior to its destruction by fire in 1941. A second fire in 1961 reduced the site to a barren rocky condition. In April 1965 a mixture of black spruce and jack pine was broadcast seeded by helicopter. The seeding produced a well-stocked stand of spruce and pine - 85 and 59 percent stocking respectively in 1970 (Richardson, 1973).

By 1970 the softwood seedlings were suffering direct competition from rapidly growing and spreading alders and other hardwood species. In June 1975, before treatment, hardwood stems outnumbered softwoods three to one, and were twice as tall on average (Table 1). A progressive increase in hardwood height is clearly evident from Block I to IV. This is at least partly related to a corresponding decrease in softwood height, and to the position of the blocks on the slope; there is a regular gentle slope upwards from Block I to Block IV. Obviously the suppression of the spruce and pine seedlings was much more intense under the 3.2 m tall hardwoods of Block IV than among the 1.6 m hardwoods of Block I.

Underneath the hardwood canopy, the ground vegetation consisted of a moss carpet. Other vegetation was sparse and weak except in open areas where ericaceous dwarf shrubs were prominent.

Table 1. Density and height of softwood regeneration and hardwood competition prior to release treatment.

	Block I	Block II	Block III	Block IV	Average
Softwoods					
Avg. Density (stems/ha) - black spruce	17 200	23 100	17 000	18 700	19 000
- jack pine	4 500	4 600	2 600	1 100*	3 200
Avg. height (cm) - black spruce	129	162	107	83	120
- jack pine	120	143	107	75	121
Hardwoods					
Avg. Density (stems/ha) - alders	45 000	42 800	45 600	51 700	46 300
- total hardwoods**	71 100	64 500	60 700	60 500	64 200
Avg. height (cm) - all hardwoods	160	202	240	321	231

*Jack pine was absent from 3 of the 5 plots in Block IV.
**Includes aspen, willow (*Salix* spp.), white birch, and pin cherry (*Prunus pensylvanica* L.f.), as well as alder.

RESULTS AND DISCUSSION

Softwood Regeneration. Average percent stocking and stem densities of black spruce and jack pine before treatment and at three dates up to four years after treatment are shown in Table 2. There were no statistically significant differences between treatments for any factor at any date, due largely to the considerable variation among individual plots. Stocking did not change appreciably after treatment except in the case of Tordon which reduced jack pine stocking after two years to

Table 2. Average percent stocking and stem density of spruce and pine before and after treatment.

Treatment	Percent stocking				Stem density (stems/ha)			
	Jun '75	May '76	Sep '77	Sep '79	Jun '75	May '76	Sep '77	Sep '79
Black spruce								
Brushcutting	86	86	88	88	18 300	12 800	12 800	12 400
Early 2,4-D	94	95	94	95	20 100	16 100	15 900	14 800
Late 2,4-D	94	94	95	95	16 200	19 500	18 600	15 800
Tordon	92	90	86	84	17 100	11 600	10 100	9 000
Control	98	99	99	99	23 400	21 100	18 700	16 300
Average	94	93	92	92	19 000	16 200	15 200	13 600
Jack pine								
Brushcutting	28	24	22	22	1 800	1 500	1 200	1 100
Early 2,4-D	42	46	46	44	3 400	2 800	2 600	2 500
Late 2,4-D	42	42	37	34	3 100	3 300	2 900	2 400
Tordon	54	40	13	13	3 600	1 900	500	400
Control	53	54	49	38	4 300	3 700	2 900	2 200
Average	44	41	33	30	3 200	2 600	2 000	1 700

less than 25 percent of its pre-treatment level. All treatments reduced softwood density below pre-treatment levels, Tordon more so than the other treatments. Although the Tordon pellets were applied only to alder clumps, considerable damage occurred to the spruce and more especially to the pine. However, enough black spruce survived to form a well-stocked stand.

Most of the change in softwood density took place within one year of treatment. The continuing reduction in spruce density and pine stocking and density in the control plots has been attributed to the accidental destruction of small weak seedlings during subplot measurement[1] (Richardson, 1979a).

All treatments caused some damage to the softwood regeneration. Most damage was caused by Tordon treatment and pine seedlings were more severely affected than spruce. Herbicide damage took the form of needle discoloration, loss of foliage, twisted or dead tops, and complete mortality. Brushcutting resulted in winter damage to exposed softwoods and some accidental mechanical damage. Recovery from all but the most severe damage was complete by 1979.

Average height and leader length of black spruce and jack pine before treatment, and two years and four years after treatment are shown in Table 3. There were no significant differences between treatments. Any retarding effect that the treatments may have had on softwood growth had been outgrown by 1979. Tordon provides the clearest example of this: in 1977, two years after treatment, average height of spruce and pine in Tordon-treated plots were almost the same as, or even less than immediately prior to treatment; but between 1977 and 1979 softwood heights in Tordon plots increased appreciably, though still less than in other plots. For black spruce, this increase was 87 percent of the average increase; it was 60 percent for jack pine.

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[1] Destruction of one seedling on a 4 m^2 quadrat is equivalent to the loss of 2 500 stems/ha.

Table 3. Average height and leader length of spruce and pine before and after treatment.

Treatment	Average height tallest stem/quadrat (cm)			Average leader on tallest stem/quadrat (cm)		
	Jun '75	Sep '77	Sep '79	Jun '75	Sep '77	Sep '79
Black spruce						
Brushcutting	135	157	187	14	13	16
Early 2,4-D	114	153	184	14	19	17
Late 2,4-D	118	154	187	15	17	16
Tordon	103	106	132	13	12	17
Control	137	176	205	17	19	16
Average	120	150	180	15	16	16
Jack pine						
Brushcutting	141	194	244	23	21	36
Early 2,4-D	154	204	262	25	25	34
Late 2,4-D	90	113	161	19	14	25
Tordon	155	149	181	26	9	30
Control	74	111	164	14	16	25
Average	121	151	205	21	18	29

There was no clear evidence shown in Table 3 of release growth on the softwoods due to any of the treatments. The reason for this may lie in the height variation between blocks described earlier. Table 4 shows the average 1979 leader length for spruce and pine on individual plots. In Block I where the competing hardwoods were smallest relative to the softwood height, the average black spruce leader length in the control plot was greater than in the herbicide or brushcutting plots. In Block IV,

Table 4. Average 1979 leader length (cm) of spruce and pine, by treatment and block.

Block	Treatment				
	Brushcutting	Early 2,4-D	Late 2,4-D	Tordon	Control
Black spruce					
I	21	17	11	11	26
II	14	16	18	22	16
III	15	18	21	14	11
IV	14	16	13	22	9
Jack pine					
I	39	25	26	21	32
II	29	33	25	29	18
III	27	36	18	33	22
IV	35	-	-	23	-

where the hardwoods were tallest, the spruce leader length in the control plot was much less than in any of the others, 59 percent less than in the Tordon plots. Between Blocks I and IV there is evidence of a progressive decrease in leader length in control plots. Such a decrease is not evident in the treated plots.

Jack pine leader lengths in control plots were greatest in Block I where the hardwoods were smallest. They were less in Blocks II and III. Jack pine was not present in several plots of Block IV. In Blocks II and III, brushcutting, early 2,4-D and Tordon resulted in better leader growth than late 2,4-D and control.

These leader length data show that where the hardwood competition was tallest the softwoods have been released by the treatments in varying degrees. Jack pine, which was probably suppressed more severely

by the competition than black spruce, exhibited release more clearly than spruce in plots with less than the tallest competition (Block II).

Hardwoods. All treatments except control caused a statistically significant decrease in hardwood cover as measured while the trees were in leaf in 1976 (Table 5). Between the measurements in 1976 and 1977 there was a further decrease in cover, averaging 21 percent, but this was non-significant and may be related to personal bias in individuals estimating cover. The 1979 measurement showed an average 43 percent increase in hardwood cover over the 1977 level. This increase is statistically significant for all treatments combined, though not for individual treatments. The greatest increase (129 percent) was in the Tordon

Table 5. Cover of hardwoods before and after treatment.

	Mean Hardwood Cover (tenths of quadrat area)							
	A. Jun '75		B. Aug '76		C. Sep '77		D. Sep '79	
Treatment		Percent Change		Percent Change		Percent Change		D as percent of A
Brushcutting	7.1ab*	-56	3.1efg	-16	2.6efg	+35	3.5efg	49
Early 2,4-D	6.8ab	-47	3.6defg	-14	3.1efg	+32	4.1cdef	60
Late 2,4-D	6.4abc	-42	3.7defg	-22	2.9efg	+62	4.7bcde	73
Tordon	7.2a	-71	2.1fg	-33	1.4g	+129	3.2efg	44
Control	7.2a	-10	6.5abc	-25	4.9abcde	+22	6.0abcd	83
Average	7.0ℓ	-46	3.8mn	-21	3.0n	+43	4.3m	61

*Means followed by the same letter are not significantly different (0.01 level). No comparison is implied between 'average' and individual treatments.

plots. Those hardwoods which were not completely killed by the treatments had begun to recover by 1979, but on average the hardwood cover was still only 61 percent of the pretreatment level (56 percent if the control is ignored).

Changes in hardwood height were reported by Richardson (1979a). As measured in 1977, two years after treatment, average height of surviving stems was less than before treatment in brushcutting and Tordon plots. Average height in 2,4-D-treated plots was slightly more than before treatment. No hardwood height measurements were made in 1979, but the only noticeable change from 1977 was in the brushcutting plots where sprouts originating after cutting continued to grow rapidly.

Hardwood density was not recorded in 1979 either. Earlier measurements showed that brushcutting and Tordon caused the greatest reductions in numbers of live hardwood stems, 98 and 86 percent respectively two years after treatment. However, many new stems appeared after treatment, particularly in the brushcutting plots where there were 25 percent more hardwood stems in total in 1977 than before treatment in 1975. Hardwood sprouting was least in the Tordon plots where total live stems in 1977 were only 27 percent of the pretreatment number (Richardson, 1979a).

CONCLUSIONS

Four years after treatment with herbicide or brushcutting to release black spruce and jack pine regeneration from competing alders and other unmerchantable hardwood species, the softwoods have shown increased

height growth which can be attributed to the treatments. This release growth was most evident where the competing hardwoods were more than twice as tall as the softwoods before treatment. This leads to the conclusion that there is no value in applying release treatments unless the competition is a major problem.

Although this experiment represents a somewhat unusual situation - a twice-burned forest site on which alders were competing with an artificially seeded stand of black spruce and jack pine - the results are relevant to other competition situations. On many cutovers in central and western Newfoundland, particularly on rich sites, natural regeneration of black spruce or balsam fir occurs mixed with hardwood regeneration, chiefly of white birch. The birch is generally about the same height as the softwoods or is slightly taller (Richardson 1979b) and is considered by many (Delaney and Cahill 1979, Richardson 1979c, van Nostrand 1979) to suppress the growth of the softwoods. However, suppression has not actually been documented. The present results suggest that removing or reducing the 'competition' would not improve softwood height growth in many cases.

All treatments except 2,4-D applied in August resulted in increased softwood leader growth. However, Tordon and brushcutting caused more mortality and damage to softwood regeneration than 2,4-D. The selective herbicide 2,4-D applied in July when hardwoods are still actively growing, is therefore recommended for situations in Newfoundland where it has been clearly established that hardwood competition is affecting softwood growth detrimentally.

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